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(54) Telecommunications cable having good adhesion between a protective jacket and strength members

(57) A telecommunications cable comprising a communications element, such as an optical fiber, and a jacket surrounding the communications element having at least one elongated strength member embedded therein is disclosed. The jacket of the telecommunications cable is formed by extruding a blend of a polyolefin material and a copolymer adhesion promoting material, such as graft copolymer of polyethylene and ethylene acrylic acid or a graft copolymer of polyethylene and maleic anhydride. The copolymer adhesion promoting material promotes adhesion between the strength member and the jacket. The resulting increase in adhesion between the strength member and the jacket improves the cable's resistance to water penetration, low temperature buckling and shrinkage as well as excessive high temperature expansion. The blending of an adhesion promoting material in the jacketing material also reduces the risk of armor cracking during cyclic flexing and strength member pistoning within the jacket.

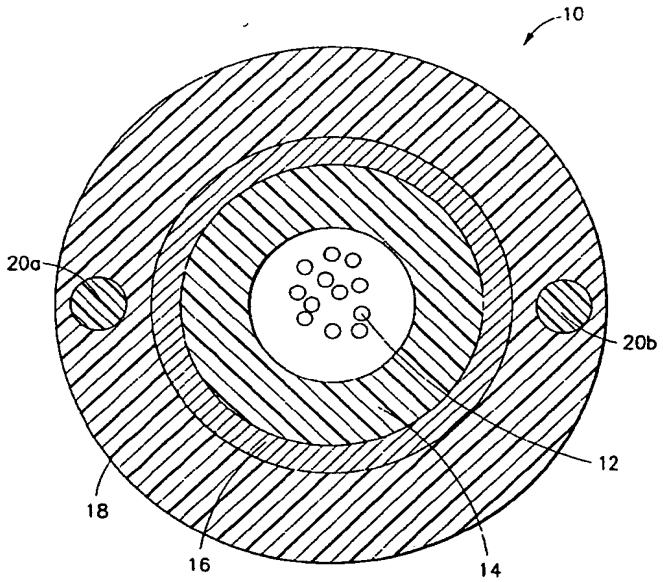

FIG. 1

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to telecommunications cables. More particularly, the present invention relates to a telecommunication cable having strength members adjacent to or embedded in a protective jacket made from a polymeric material having an adhesion promoter blended therein.

Description of the Prior Art

[0002] Telecommunications cables containing optical fiber cables have been used by the telecommunications industry for a number of years to transmit information at very high rates over long distances. Because the optical fiber transmission elements are delicate, the telecommunications cables are provided with members which are designed to protect the optical fibers. For example, in a typical optical fiber telecommunications cable, one or more optical fibers are disposed in a buffer tube which provides some protection against abrasion, as well as outside tensile and compressive forces. In a basic central tube design, a single buffer tube may be surrounded by an armor layer made from aramid yarns, water blocking tapes, metallic sheaths or some combination of such materials. The armor layer is typically surrounded by an outer protective sheath made from a polyolefin material such as medium density polyethylene (MDPE) or high density polyethylene (HDPE). To provide additional compressive and tensile strength to the cable, the outer protective jacket may be extruded over strength members made from composite materials containing glass reinforced fibers or steel so that such members become embedded in the outer protective jacket.

[0003] In some cables, copolymer adhesion promoters, such as ethylene-acrylic acid (EAA) are applied as a coating on composite strength members to promote adhesion between the strength members and the jacket extruded thereover. Alternatively, steel armor may be precoated with a copolymer material which promotes adhesion. Such strength members are marketed by the Dow Chemical company under the ZETABON trademark. The jacket material is then extruded over this copolymer coated steel armor. Copolymer coatings, however, have the disadvantage that adhesion cannot be controlled during cable manufacturing.

[0004] Control of bonding is desirable in fiber optic cables to allow a combination of mechanical integrity and ease of cable access. If adhesion between the jacket and strength members or jacket is too low, debonding may occur during handling or installation. If jacket debonding occurs, the cable may show numerous mechanical or other problems. For example, if the strength members become debonded from the jacket pistoning of the strength members may be seen with temperature variation due to the different coefficient of thermal expansion (CTE) values for the different materials. If the jacket and strength members do not remain coupled, low temperature cable contraction may be too high and attenuation may result. Additionally, debonding can result in water penetration failures in the cable. If the level of adhesion is too high, especially between steel armor ad the jacket, cable access may be difficult for splicing operations thereby increasing the effective time for cable access and splicing.

[0005] To control bonding, some have applied hot melt or other types of adhesives to the strength members or armor prior to the extrusion of the jacket material over the strength member or armor. These materials have become necessary to obtain the desired level of mechanical coupling or bonding between the jacket and the strength members or armor. However, the application of these materials to the strength member or armor during the cable manufacturing process increases the cost of manufacturing by adding another step to the manufacturing process.

[0006] Accordingly, what is needed is a mechanism to provide and control the adhesion between embedded elongated strength members and the protective jacket material during the jacketing process without significantly adding to the manufacturing cost of the cable. The present invention is intended to provide such a mechanism.

SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to provide a telecommunications cable having a jacket which is reinforced by elongated strength members embedded therein.

[0008] It is another object of the present invention to provide a telecommunications cable having a jacket which has controlled adhesion to the elongated strength members embedded therein.

[0009] It is yet another object of the present invention to provide a telecommunications cable having a jacket which has controlled adhesion to an armor layer adjacent thereto and in contact therewith.

[0010] These objects are accomplished, at least in part, by a telecommunications cable comprising a communications element, and a jacket surrounding the communications element having at least one elongated strength member embedded therein, wherein the jacket is formed by extruding a blend of a polyolefin material and a copolymer adhesion promoting material which promotes adhesion between the strength member and the jacket.

[0011] Other objects and advantages of the present invention will become apparent to those skilled in the art from the following detailed description read in conjunction with the attached drawing and claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The drawings, not drawn to scale, are:

FIG. 1, which is a cross-sectional view of one embodiment of a telecommunications cable made according to the present invention;

FIG. 2, which is a cross-sectional view of another embodiment of a telecommunications cable made according to the present invention;

FIG. 3A, which is a schematic illustration of an elongated, fiberglass reinforced epoxy strength member after it was pulled out of a medium density polyethylene jacket containing no adhesion promoter; and

FIG. 3B, which is a schematic illustration of an elongated, fiberglass reinforced epoxy strength member after it was pulled out of a medium density polyethylene jacket made with an adhesion promoter according to the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

[0013] Referring to FIG. 1, an embodiment of a telecommunications cable **10** made according to the present invention is formed, in part, by one or more communications elements **12**, which are preferably ordinary optical fibers. A centrally located buffer tube **14** is extruded over the communications elements **12** so as to envelope them. The buffer tube may be extruded from any extrudable thermoplastic material such as polyvinyl chloride, polyethylene, polycarbonate (PC), polybutylene terephalate (PBT) or a thermoplastic polyolefin elastomer compound, but preferably, the buffer tube **14** is extruded from a nucleated polypropylene-polyethylene copolymer. Such a material is described in U.S. Patent No. 5,574,814. Techniques for extruding thermoplastic material to form the buffer tube **14** over the communications elements **12** are well known in the art and therefore not described herein. Water blocking gels, water swellable yarn or water swellable powders (not shown) may also be disposed in the buffer tube **14**, if desired. The buffer tube **14** provides the primary structure to protect delicate communications elements **12**, such as optical fibers, contained therein.

[0014] To provide support and protection for the buffer tube **14** in the cable **10** after the buffer tube **14** is formed over the communications elements **12**, the buffer tube **14** may be surrounded by a layer **16** formed by radial strength yarns, filling or flooding compounds, swellable water blocking tapes, corrugated metallic sheathing, or a combination of these various armor materials. Methods for forming this layer **16** over the buffer tube **14** are well known by those skilled in the art and a detailed description of a typical armor layer can be found in U.S. Patent No. 5,029,974, which is incorporated herein by reference in its entirety.

[0015] Finally, the telecommunications cable is completed by the extrusion of a polyolefin, such as a medium density polyethylene (MDPE) or high density polyethylene (HDPE), outer jacket **18** over the buffer tube **14**, or the layer **16** if a buffer tube or a layer has been provided. Typically, to provide additional strength to the telecommunications cable **10**, elongated strength members **20a**, **20b** are positioned in a parallel spaced apart relationship relative to the buffer tube, or to the layer **16** if the cable **10** has such a layer, prior to the extrusion of the outer jacket **18**. The elongated strength members **20a**, **20b** may be formed from a composite material such as a thermoplastic polymer reinforced with glass fibers, steel alloys or other suitable reinforcing materials. Provided that good adhesion is obtained between the outer jacket **18** and the elongated strength members **20a**, **20b** so that such components are mechanically coupled, the elongated strength members **20a**, **20b** enable the cable **10** to resist ordinary compressive and tensile forces which are placed on the cable **10** during installation and use in the field. It is important that such forces are resisted so that changes in the length of the cable **10** during installation and use are minimized to prevent straining, breaking or substantial bending of the communications elements, which is undesirable.

[0016] As illustrated in FIG. 2, alternatively, the jacketing material may be extruded directly around the communications elements **12** to form a surrounding jacket and waterblocking compound while encapsulating the strength members **20a**, **20b**. Such a process and cable design eliminates the need for a buffer tube.

[0017] To promote good adhesion between the outer jacket **18**, the elongated strength members **20a**, **20b** and between the outer jacket **18** and the layer **16**, if the cable **10** has such a layer and the layer is of the typical armor type, the MDPE or HDPE jacketing material is blended with a graft copolymerized adhesion promoter prior to extrusion. According to the present invention, the graft copolymer is configured to contain polymer segments of two dissimilar chemical species that can promote improved adhesion between two dissimilar substrates, i.e., the polyolefin jacket and the elongated metallic or polymer strength member. Adhesion is promoted by providing chemical units within the jacketing polymer that migrate to the first substrate with like chemistry, such as the elongated glass reinforced polymer strength member. The same graft copolymer can have other chemical units that are similar to the other substrate, such as the polyolefin jacket material.

[0018] Graft copolymerized adhesion promoters that will work in accordance with the present invention include polar molecules such as ethylene acrylic acid or maleic anhydride which can be graft copolymerized to a polyolefin backbone to form an adhesion promoting material. The adhesion promoting material is blended into the MDPE, HDPE or polyolefin jacket material. This blending can take place directly during jacketing or as a prior compounding step. The polarity of the polar acryl-

ic acid or maleic anhydride molecule provides good adhesion to metallic, glass or epoxy substrates. The polyolefin backbone has good compatibility and miscibility with the polyolefin jacket material. As jacket material is extruded over the elongated strength member during cable manufacturing, the similar chemical components of the graft copolymer migrate to the surface of the elongated strength member. This lowers the interfacial surface energy between the elongated strength member and the jacket material, thereby increasing adhesion between the elongated strength member and the jacket material. Two illustrative examples are set forth below.

Example 1

[0019] Two cables containing embedded fiberglass reinforced epoxy elongated strength elements and jacketed with Union Carbide DHDA-8864 MDPE were manufactured under identical processing conditions with and without the addition of adhesion promoter. The cable that did not include the adhesion promoter failed a water penetration test with a penetration result of over 1M using a 1M head of water within one hour. A cable containing 5 weight percent of the adhesion promoter Polybond® 3009 in the polyolefin jacketing material blend had water penetration of less than 2 cm in 24 hours. Polybond® 3009 is a polyethylene/maleic anhydride graft copolymer produced by Uniroyal Chemical. The glass reinforced polymer (GRP) pullout forces for the cable that included no adhesion modifier were as low as 20 pounds, whereas the GRP pullout force on cables made with the blend containing Polybond® 3009 surpassed 100 pounds. The blending of 5 weight percent Polybond® 3009 adhesion promoter with the polyolefin jacketing material was sufficient to change the mode of pullout failure from interfacial failure between the reinforcing member to failure of the MDPE surrounding the reinforcing member.

[0020] FIG. 3A schematically shows the debonded surface of an elongated fiberglass reinforced epoxy rod **20a** after a pullout test from a jacket containing no adhesion promoter. No evidence of the MDPE jacket remains on the rod after the pullout test, leaving it with a substantially clean surface. FIG. 3B schematically shows the debonded surface of fiberglass reinforced epoxy rod **20a** after a pullout test from a jacket containing 5% Polybond® 3009 adhesion promoter. The debonded surface of the sample made with the blend of polyolefin and the adhesion promoter shows that the interfacial strength between the reinforcing member and the MDPE jacket was significantly increased to the point where jacket material **18** remains on the reinforcing member after the pullout test. The resulting increase in interfacial strength between the strength member and the jacket increases reinforcing member pullout force and also causes a failure mode that can dissipate more energy.

Example 2

[0021] Two cables containing embedded steel strength elements and jacketed with Union Carbide DHDA-8864 MDPE were manufactured under identical processing conditions with and without the addition of adhesion promoter. The cable that did not include the adhesion promoter in the jacketing material failed a water penetration test with a penetration result of over 1M using a 1M head of water within one hour. A cable made from a blend of 95 weight percent polyolefin and 5 weight percent of the adhesion promoter Polybond® 1009 had water penetration of less than 2 cm in 24 hours. Polybond® 1009 is a polyethylene/acrylic acid graft copolymer produced by Uniroyal Chemical.

[0022] The increased adhesion between strength member and jacket material obtained by blending the adhesion promoter into the jacketing material reduces pistoning and improves water tightness of the cable as shown by the improved water penetration test results. Because the adhesion promoting material can be blended into the MDPE or HDPE jacket material, manufacturing costs are potentially lower due to the elimination of a separate strength member coating step and coating equipment.

[0023] It will thus be seen that the objects and advantages set forth above and those made apparent from the preceding descriptions, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that the matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall there between.

Claims

1. A telecommunications cable (10) comprising:

   a communications element (12); and
   a jacket (18) surrounding the communications element (12) having at least one elongated strength member (20a, 20b) embedded therein, wherein the jacket (18) is formed by extruding a blend of a polyolefin material and a copolymer adhesion promoting material which promotes adhesion between the strength member (20a, 20b) and the jacket (18).

2. A telecommunications cable (10) comprising :

   a communications element (12);
   an armor layer (16) surrounding the communi-

cations element (12); and
a jacket (18) in contact with the armor layer (16), wherein the jacket (18) is formed by extruding a blend of a polyolefin material and a copolymer adhesion promoting material which promotes adhesion between the armor layer (16) and the jacket (18).

3. The telecommunications cable (10) of claim 2, wherein the jacket (18) has at least one elongated strength member (20a, 20b) embedded therein and wherein the copolymer adhesion promoting material further promotes adhesion between the elongated embedded strength member (20a, 20b) and the jacket (18).

4. The telecommunications cable (10) of any of claims 1 to 3, wherein the copolymer adhesion promoting material is selected from the group consisting of a graft copolymer of maleic anhydride and polyethylene and a graft copolymer of ethylene acrylic acid and polyethylene.

5. The telecommunications cable (10) of any of claims 1 to 4, wherein the polyolefin material is selected from the group consisting of ethylene polymer or copolymer, copolymerized and/or grafted with a functional monomer which is maleic anhydride and/or acrylic acid or esters thereof.

6. The telecommunications cable (10) of any of claims 1 to 5, wherein the graft copolymer comprises approximately 5 weight percent of the blend.

7. The telecommunications cable (10) of any of claims 1 to 6, wherein the communications element (12) is an optical fiber.

8. The telecommunications cable (10) of any of claims 2 to 7, wherein the polyolefin material is selected from the group consisting of medium density polyethylene and high density polyethylene, wherein the material forming the armor layer (16) is selected from the group consisting of aramid yarns.

9. The telecommunications cable (10) of any of claims 1 and 3 to 8, wherein the polyolefin material is selected from the group consisting of medium density polyethylene and high density polyethylene, wherein the material forming the elongated strength member (20a, 20b) is selected from the group consisting of fiberglass reinforced epoxy and steel.

10. A method for making a telecommunications cable (10), the method comprising:

providing a communications element (12);
providing at least one elongated strength member (20a, 20b);
extruding a blend of a polyolefin material and a copolymer adhesion promoting material to form a jacket (18) surrounding the communications element (12) having the at least one elongated strength member (20a, 20b) embedded therein.

11. A method for making a telecommunications cable (10), the method comprising:

providing a communications element (12);
providing an armor layer (16) around the communications element (12);
extruding a blend of a polyolefin material and a copolymer adhesion promoting material to form a jacket (18) contacting the armor layer (16).

12. The method of claim 10 or 11, wherein the copolymer adhesion promoting material is selected from the group consisting of a graft copolymer of maleic anhydride and polyethylene and a graft copolymer of ethylene acrylic acid and polyethylene.

13. The method of any of claims 10 or 11, wherein the copolymer adhesion promoting material is selected from the group consisting of ethylene polymer or copolymer, copolymerized and/or grafted with a functional monomer which is maleic anhydride and/or acrylic acid or esters thereof.

14. The method of any of claims 10 to 13, wherein the polyolefin material is selected from the group consisting of medium density polyethylene and high density polyethylene, wherein the material forming the elongated strength member (20a, 20b) is selected from the group consisting of fiberglass reinforced epoxy and steel and wherein the copolymer adhesion promoting material is selected from the group consisting of a graft copolymer of maleic anhydride and polyethylene and a graft copolymer of ethylene acrylic acid and polyethylene.

15. The method of any of claims 10 to 13, wherein the polyolefin material is selected from the group consisting of medium density polyethylene and high density polyethylene, wherein the material forming the elongated strength member (20a, 20b) is selected from the group consisting of fiberglass reinforced epoxy and steel and wherein the copolymer adhesion promoting material is selected from the group consisting of ethylene polymer or copolymer, copolymerized and/or grafted with a functional monomer which is maleic anhydride and/or acrylic acid or esters thereof.

16. The method of any of claims 10 to 14, wherein the polyolefin material is selected from the group con-

sisting of medium density polyethylene and high density polyethylene, wherein the material forming the armor layer (16) is selected from the group consisting of aramid yarns and wherein the copolymer adhesion promoting material is selected from the group consisting of a graft copolymer of maleic anhydride and polyethylene and a graft copolymer of ethylene acrylic acid and polyethylene.

17. The method of any of claims 10 to 14, wherein the polyolefin material is selected from the group consisting of medium density polyethylene and high density polyethylene, wherein the material forming the armor layer (16) is selected from the group consisting of aramid yarns and wherein the copolymer adhesion promoting material is selected from the group consisting of ethylene polymer or copolymer, copolymerized and/or grafted with a functional monomer which is maleic anhydride and/or acrylic acid or esters thereof.

18. The method of any of claims 10 to 17, wherein the communications element (12) is an optical fiber.

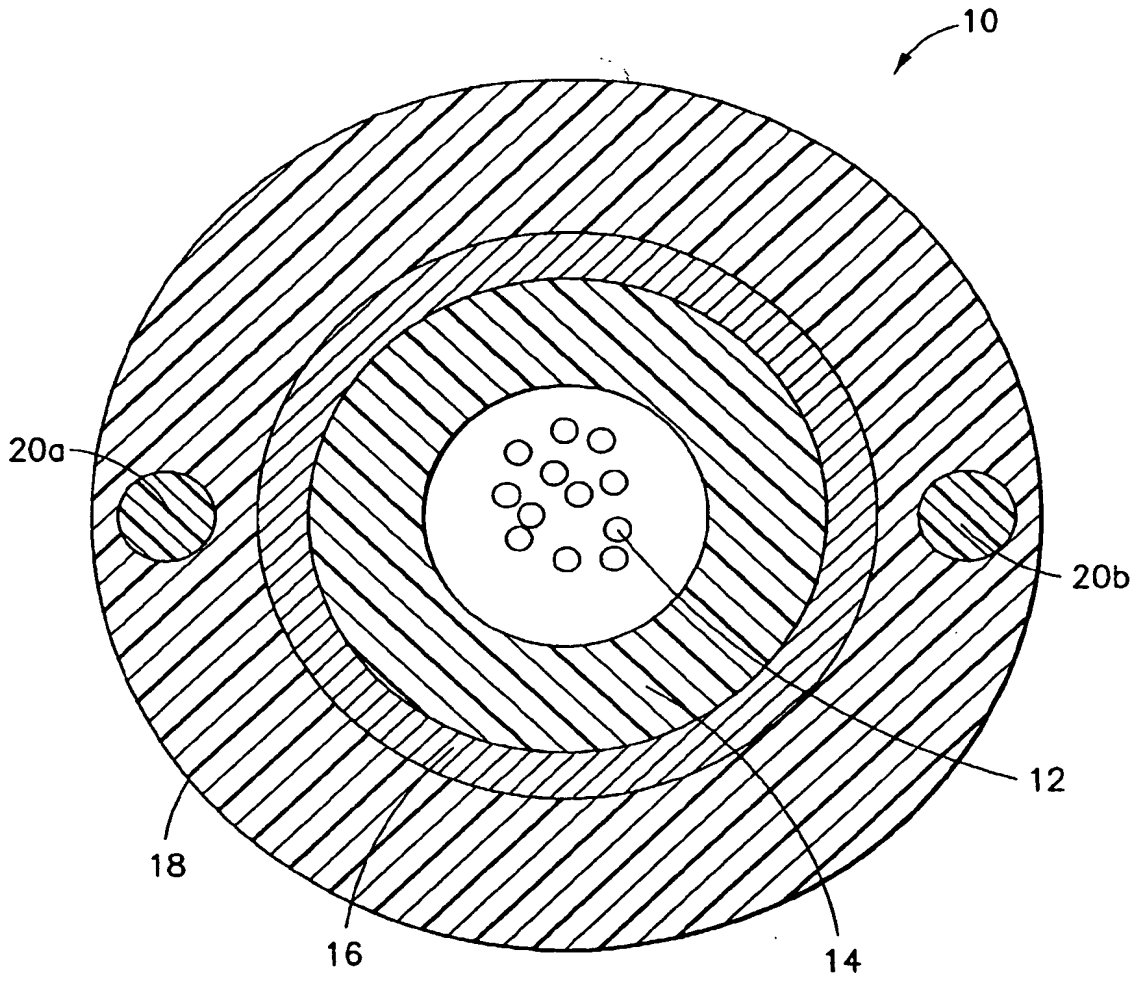

FIG. 1

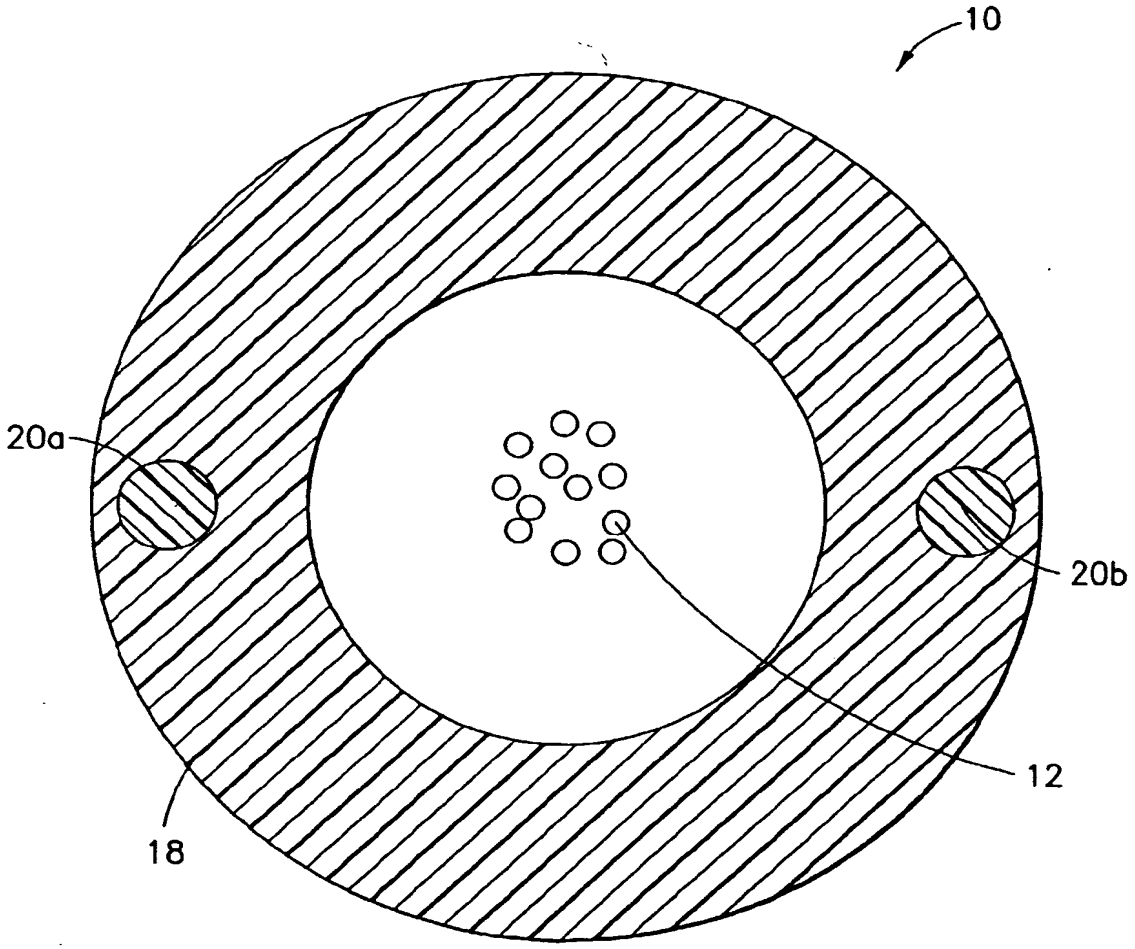

FIG.2

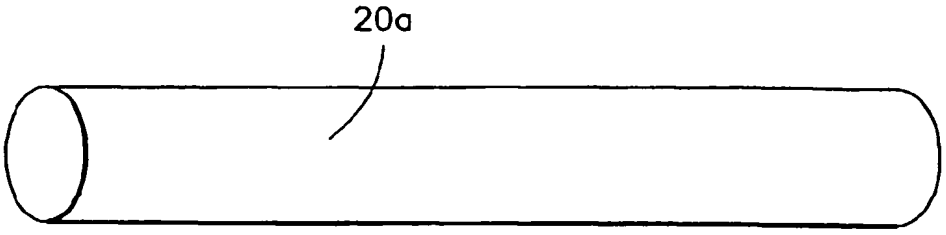

FIG.3A

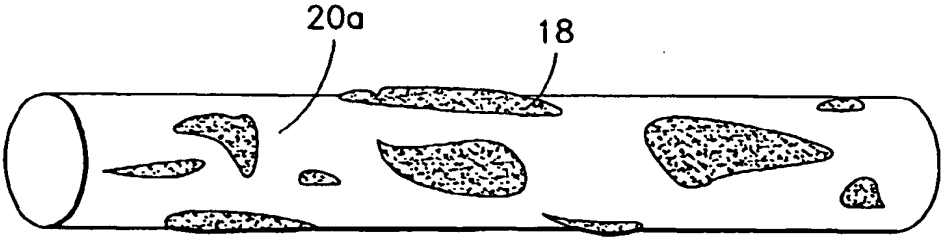

FIG.3B

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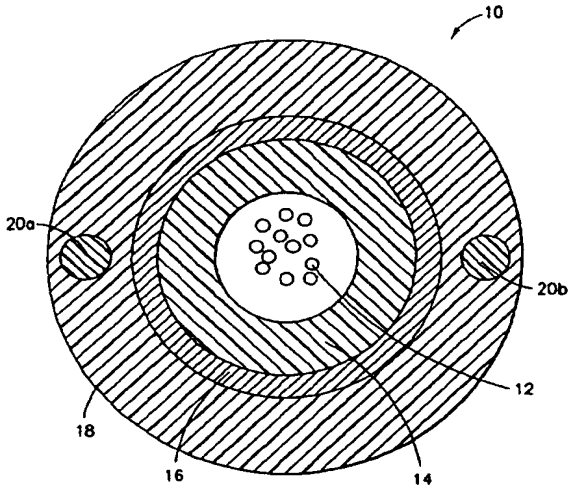

FIG.1

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 40 2247

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 0 373 846 A (AMERICAN TELEPHONE & TELEGRAPH) 20 June 1990 (1990-06-20) * column 9, line 4 - line 17; figures 1-10 *	1,2,10, 11	G02B6/44
A	EP 0 361 863 A (AMERICAN TELEPHONE & TELEGRAPH) 4 April 1990 (1990-04-04) * abstract; figures 1,2 *	1,2,10, 11	
P,A	EP 0 968 809 A (CIT ALCATEL) 5 January 2000 (2000-01-05) * abstract; figure 1 *	1,2,10, 11	
A	US 5 509 097 A (TONDI-RESTA JOSE L ET AL) 16 April 1996 (1996-04-16) * abstract; figure 1 *	1,2,10, 11	
A	US 5 384 192 A (LONG TIMOTHY E ET AL) 24 January 1995 (1995-01-24) * abstract *	1,2,10, 11	
A	US 5 194 509 A (OHLINGER RAINER ET AL) 16 March 1993 (1993-03-16) * abstract *	1,2,10, 11	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G02B
A	US 5 189 120 A (HASENBEIN NORBERT ET AL) 23 February 1993 (1993-02-23) * abstract *	1,2,10, 11	
A	US 5 155 304 A (GOSSETT KEITH A ET AL) 13 October 1992 (1992-10-13) * abstract; figure 1 *	1,2,10, 11	
A	US 5 050 957 A (HAMILTON ALFRED S ET AL) 24 September 1991 (1991-09-24) * abstract; figure 1 *	1,2,10, 11	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 February 2002	Malic, K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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& : member of the same patent family, corresponding document

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EP 00 40 2247

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 5 029 974 A (NILSSON RICHARD C) 9 July 1991 (1991-07-09) * abstract; figure 1 *	1,2,10, 11	
A	US 4 906 690 A (HASENBEIN NORBERT ET AL) 6 March 1990 (1990-03-06) * abstract *	1,2,10, 11	
A	US 4 844 575 A (REYNOLDS MICKEY R ET AL) 4 July 1989 (1989-07-04) * abstract; figure 1 *	1,2,10, 11	
A	US 4 842 947 A (JACHEC KEVIN V ET AL) 27 June 1989 (1989-06-27) * abstract *	1,2,10, 11	
A	US 4 765 712 A (BOHANNON JR WILLIAM D ET AL) 23 August 1988 (1988-08-23) * abstract; figure 1 *	1,2,10, 11	
A	US 4 743 085 A (JENKINS ARTIS C ET AL) 10 May 1988 (1988-05-10) * abstract; figure 1 *	1,2,10, 11	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
A	US 4 723 831 A (JOHNSON BRIAN D ET AL) 9 February 1988 (I988-02-09) * abstract; figure 1 *	1,2,10, 11	
A	US 4 241 979 A (GAGEN PAUL F ET AL) 30 December 1980 (1980-12-30) * abstract; figure 1 *	1,2,10, 11	

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 40 2247

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-02-2002

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0373846	A	20-06-1990	CA	2005114 A1	14-06-1990
			CN	1043793 A ,B	11-07-1990
			DE	68915969 D1	14-07-1994
			DE	68915969 T2	22-09-1994
			DK	629289 A	15-06-1990
			EP	0373846 A2	20-06-1990
			KR	178021 B1	15-05-1999
			US	5109457 A	28-04-1992
EP 0361863	A	04-04-1990	US	4909592 A	20-03-1990
			CA	1329241 A1	03-05-1994
			DE	68912047 D1	17-02-1994
			DE	68912047 T2	28-04-1994
			DK	478789 A	30-03-1990
			EP	0361863 A1	04-04-1990
			ES	2047680 T3	01-03-1994
			JP	2155122 A	14-06-1990
			JP	2726714 B2	11-03-1998
EP 0968809	A	05-01-2000	US	6041153 A	21-03-2000
			EP	0968809 A1	05-01-2000
US 5509097	A	16-04-1996	AU	681244 B2	21-08-1997
			AU	1618195 A	16-11-1995
			BR	9501340 A	14-11-1995
			CA	2145215 A1	08-10-1995
			EP	0676654 A2	11-10-1995
			NZ	270898 A	29-01-1997
US 5384192	A	24-01-1995	NONE		
US 5194509	A	16-03-1993	DE	3639564 A1	01-06-1988
			AT	92503 T	15-08-1993
			CA	1333826 A1	03-01-1995
			DE	3786884 D1	09-09-1993
			EP	0268294 A2	25-05-1988
US 5189120	A	23-02-1993	DE	3639566 A1	01-06-1988
			AT	92504 T	15-08-1993
			CA	1333825 A1	03-01-1995
			DE	3786886 D1	09-09-1993
			EP	0269000 A2	01-06-1988
US 5155304	A	13-10-1992	CA	2046263 C	20-06-1995
			EP	0468689 A1	29-01-1992
			JP	2603377 B2	23-04-1997

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 40 2247

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The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-02-2002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5155304 A		JP 4250405 A	07-09-1992
		MX 174460 B	17-05-1994
US 5050957 A	24-09-1991	CA 2040973 C	07-03-1995
		EP 0454433 A2	30-10-1991
		JP 4226408 A	17-08-1992
US 5029974 A	09-07-1991	AT 170988 T	15-09-1998
		CA 2034629 A1	23-07-1991
		CA 2034629 C	22-03-1994
		DE 69032644 D1	15-10-1998
		DE 69032644 T2	17-06-1999
		DK 438684 T3	07-06-1999
		EP 0438684 A2	31-07-1991
		ES 2123494 T3	16-01-1999
		FI 910298 A	23-07-1991
		JP 4212907 A	04-08-1992
		MX 169987 B	03-08-1993
		NO 301195 B1	22-09-1997
		RU 2043645 C1	10-09-1995
US 4906690 A	06-03-1990	DE 3800307 A1	20-07-1989
		AT 89838 T	15-06-1993
		CA 1333827 A1	03-01-1995
		DE 3881371 D1	01-07-1993
		EP 0323650 A2	12-07-1989
US 4844575 A	04-07-1989	CA 1324276 A1	16-11-1993
		EP 0286349 A2	12-10-1988
US 4842947 A	27-06-1989	CA 1288188 A1	27-08-1991
		DE 68920160 D1	09-02-1995
		DE 68920160 T2	08-06-1995
		EP 0325952 A2	02-08-1989
		JP 2003479 A	09-01-1990
		CA 1288536 A1	03-09-1991
		DE 3782885 D1	14-01-1993
		DE 3782885 T2	17-06-1993
		EP 0257323 A1	02-03-1988
		JP 2048469 C	25-04-1996
		JP 6060300 B	10-08-1994
		JP 63035675 A	16-02-1988
		JP 1905690 C	24-02-1995
		JP 4038227 B	23-06-1992
		JP 63212544 A	05-09-1988
		US 4774144 A	27-09-1988

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 40 2247

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-02-2002

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4765712	A	23-08-1988	AU	579034 B2	10-11-1988
			AU	6804387 A	06-08-1987
			CA	1272898 A1	21-08-1990
			CH	671833 A5	29-09-1989
			DE	3702323 A1	06-08-1987
			DK	37087 A	20-11-1987
			FR	2593929 A1	07-08-1987
			GB	2186098 A ,B	05-08-1987
			IT	1216863 B	14-03-1990
			JP	2040312 C	28-03-1996
			JP	7052252 B	05-06-1995
			JP	62191811 A	22-08-1987
			US	RE33459 E	27-11-1990
US 4743085	A	10-05-1988	CA	1294165 A1	14-01-1992
			CN	87103827 A ,B	06-04-1988
			DE	3751213 D1	11-05-1995
			DE	3751213 T2	10-08-1995
			DK	271887 A	29-11-1987
			EP	0248221 A2	09-12-1987
			ES	2070114 T3	01-06-1995
			JP	2523129 B2	07-08-1996
			JP	63026609 A	04-02-1988
			KR	9613801 B1	10-10-1996
US 4723831	A	09-02-1988	EP	0227326 A2	01-07-1987
			JP	62144121 A	27-06-1987
US 4241979	A	30-12-1980	CA	1128344 A1	27-07-1982
			DE	2953492 T	12-02-1987
			ES	487794 D0	01-11-1980
			ES	8100496 A1	16-01-1981
			FR	2447042 A1	14-08-1980
			GB	2057710 A ,B	01-04-1981
			IT	1128858 B	04-06-1986
			JP	1057764 B	07-12-1989
			JP	56500428 T	02-04-1981
			KR	8401110 Y2	23-06-1984
			WO	8001517 A1	24-07-1980

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82